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"PATENT APPLICATION"

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

EFIM S. STATNIKOV

U.S. Serial No. 10/797,016 Group Art Unit 3683

Filed: March 11, 2004 R. Siconolfi, Examiner

ULTRASONIC MACHINING AND RECONFIGURATION OF BRAKING SURFACES

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Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

DECLARATION OF EFIM S. STATNIKOV

Dear Sir:

I, Efim S. Statnikov, declare as follows:

1. I am the named inventor in the captioned application Serial No. 10/797,016;

2. I am familiar with the official action mailed April 21, 2005 wherein claims 31-35, 37 and 39-43 of the captioned application have been rejected as being obvious under 35 U.S.C. §103 in view of the disclosures in U.S. Patent Nos. 5,352,305 (Hester) and 3,274,033 (Jacke);

3. I have reviewed the disclosures of each of Hester and Jacke which describe, respectively, prestressing surfaces of brake drums and brake rotors by subjecting the surface to shot peening, and relieving residual stress in metallic welds by pressing an ultrasonic horn transducer against a weld;

4. The structure of a surface of a braking drum or rotor reworked by shot peening as disclosed in Hester or contact introduction of ultrasonic energy to a metallic weld as disclosed in Jacke is different from the structure in an ultrasonically impact reworked metallic braking drum or rotor according to my claimed invention in that, among other things, the latter has a braking surface which has been plastically deformed, smoothed and has a compressed sub-surface layer which neither shot peening nor contact transfer of ultrasound can provide;

5. Shot peening as described in Hester creates displacements of surface material about impact points establishing a rim pattern of roughened peaks to mask former tool marks and tensile forces inherently introduced by initial tooling procedure;

6. Shot peening specifically roughens a braking surface and does not provide a normalized relief, a smoothed plastically deformed surface of the metal or extended ultrasonic plastic deformation of the metal underlying the surface;

7. Contact transfer of ultrasound as described in Jacke also does not affect the structure and condition of the subsurface material by ultrasonic plastic deformation under high or compression stresses in the manner of ultrasonic impact;

8. Pressing of an ultrasonic horn transducer against a metallic surface as described in Jacke reduces forces between adjacent grains in the metal allowing them to rotate relative to one another but does not affect the grain structure itself, whereas modified material structural fragments occur at and under an ultrasonically impact reworked metallic surface at all levels thereof;

9. Introduction of ultrasound into a surface material by impact provides a structure distinct from that provided by ultrasonic contact, namely random impact upon the treated surface and ultrasonic periodic oscillations of impact elements with the treated

material during these impacts create stress waves within the material which reduce the material resistance to deformations during impact, thus activating plastic deformation of the treated material that, in turn, initiates the formation of a region of compressive stresses with magnitude and distribution being of an exponential nature, the compressive stresses being maximum at the surface and tapering to reduced magnitude reaching to an internal unstressed base metal site within the material.

10. The combination of the aperiodic and periodic effects upon the surface causes fast heating thereof in the impact region up to material structure transformation temperatures and similar quick heat removal from this region during pause between impacts thereby presenting another tool to optimize the properties and condition of the surface material under industrial conditions of production, in particular, examples of such properties include increased surface resistance to contact damages, abrasive wear, thermal and cyclic fatigue, corrosion and corrosion fatigue, improved frictional performance of the surface and reduced braking period, reduced level of process-induced residual stresses

(caused, for example by shrinkage in casting molds) followed by a uniform distribution thereof within a product body and beneficial recrystallization of the material structure at marco, micro and nano levels in the treatment area.

11. The above-described mechanism of affecting the material structure causes recrystallization and phase changes of the material structure at and under the surface and grain refinement under the influence of (induced by this mechanism) stresses, deformations, relaxation thereof and high-speed processes of local heating and cooling in a solid condition of the treated object, wherein these structural changes improve product material performance, remain in the material during the entire usage period of a product, and the process of their formation ceases directly after termination of ultrasonic impact treatment;

12. An ultrasonically impact reworked braking surface, wherein the braking surface was previously machined and roughened, has surface modification resultant from, among other things, compressing a surface layer thereby strengthening the surface material to exceed the yield point of the base

material to produce a surface compression strength during braking that exceeds the yield point of the brake drum or rotor material;

13. Additionally, the topography of the surface is smoothed during its plastic deformation as a result of impacting elements moving across the surface to provide specified macrorelief and microrelief that replace a previously machined tool marked surface with a smoothed (as described above) frictional surface with superior properties for engagement with a brake pad frictional surface under conditions of dry sliding contact and loading transmitting to a brake drum or rotor through a brake pad frictional surface, an example of deformation in an ultrasonically impacted structure being shown in Figures 7A-7D as described at pages 21-24 of the captioned application;

14. A braking surface which has been reworked by ultrasonic impact is distinct from a surface which has been reworked by shot peening or contact introduction of ultrasonic energy as described in Hester and Jacke, respectively, in that a reworked surface by ultrasonic impact has been impacted over a predetermined zone by small area impacting needle element(s) striking and

compressing the braking surface at a high velocity, whereas shot peening uses a lesser velocity, larger-area peening ball, deformation of surface into a crater with a surrounding ridge ring and does not allow for control at point of impact thus preventing control of actual impact intensity and providing only a single component surface texture; and whereas contact introduction of ultrasonic energy does not provide any impact and thus can not provide any structural modification of the braking surface which results from impact;

15. In an ultrasonically impact reworked braking surface deformation is provided in the surface structure resulting in a strengthened material which achieves substantial improvement in braking surface performance, based on, for example, a surface layer modified to a greater depth, e.g. relaxation, in the order of about 12 mm (which includes the limits of braking wear depth) as compared to prior art where surface modification is to the depths of only about 2-3 mm, which does not significantly improve braking wear life; and

16. I declare that all statements made herein are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful, false statements may jeopardize the validity of the application or any patent resulting therefrom.

Efim S. Statnikov

Date: October 12, 2005